트래픽 측정에 기반한 네트워크 게임 트래픽 생성기*

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Measurement based Traffic Generator for Network Game

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Abstract

Developers of network games have used several prediction techniques for hiding transmission delay to support the real-time requirement of network games. Nowadays many researches that are related with network game are in progress to solve delay problems more radically, such as to propose new routers architecture and transport protocols suitable to characteristics of network game traffic. So for these advanced researches the tasks to grasp the traffic characteristics of a network game are needed.

In this paper we aimed to capture the traffic of MMORPG and present the statistical analysis of measured data. The measurement and the analysis were accomplished with the server of 'Lineage' that regarded as the most successful MMORPG. Next, we have implemented a traffic generator that reflects the characteristics of MMORPG and shown that the trace generated by MMORPG traffic generator had identical characteristics with actual traffic using statistical testing method. We expect that this traffic generator can be used in many researches related with a network game.

1. Introduction

As the network game traffics are growing with high real time requirements, the interests of research areas and ISPs are increasing [1]. While existing researches applied to the network games that the number of participants is small, but MMORPG (Massively Multi-player Online Role-Playing Game) that thousands of users could be playing at the same time is most popular in domestic. We aimed to capture the traffic of MMORPG and present the statistical analysis of measured data to present the model that reflects a domestic reality.

The measurement and the analysis were accomplished with the server of 'Lineage' that regarded as the most successful MMORPG. And we have implemented a traffic generator that reflects the characteristics of MMORPG.

This paper consists of as follows. In chapter 2 we explain the background about network games and in chapter 3 we present the details of measured data and the analysis results. In chapter 4 we explain the architecture of a traffic generator and in chapter 5 show that the trace generated by generator has identical characteristics with actual traffic. At last we refer a hereafter research subject with the conclusion.

2. Target

Nowadays the measurement about a network game traffic has been limited with RTS an FPS [2][3]. Since FPS and RTS games limit the number of concurrent players, they don't consider scalability. So it's reasonable solution to choose UDP on P2P topology [4]. On the other hand the MMORPG is designed as client-server topology that should consider scalability. So current research related with network game traffic can't represent the characteristics of MMORPG. So we aimed to present the characteristics of MMORPG traffic.

We chose Lineage as a target among MMORPGs. 'Lineage' is a famous MMORPG developed by NCSoft in Korea [5]. Simultaneous participants in this game are over 300 thousands. It has more than 2 million registered users around the world. We accomplished the traffic

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measurement on Lineage server under the support of NCSoft.

Lineage use TCP. So through measurement and analysis of Lineage Traffic we can see the characteristics of MMORPG traffic choosing client-server topology and TCP.

3. Characterization of MMORPG Traffic

3.1. Summary

We have captured 'Lineage' traffic for 8 days and could store 281Gbytes of raw data. We could capture total 149,960 flows. Average connection time of these really connected flows was about 31 minutes. Total packet number was 1,860,209,597 from client and 1,640,323,336 from server.

3.2. Packet Size

Table 1 shows the statistics about overall packet number and packet size. The smallest packets have no data and have just 40 bytes of header such as SYN, ACK and FIN.

Table 1. Statistics about Packet Size

	Server → Client	Client → Server
Largest Size	1,500 bytes	1,500 bytes
Smallest Size	40 bytes	40 bytes
Average Size	76.73 bytes	49.04 bytes
Standard Dev	58.60	2.52

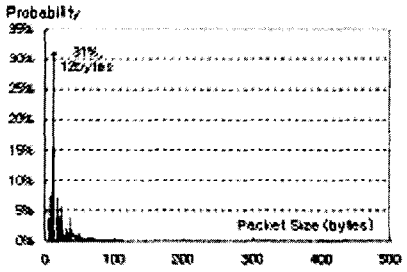

Figure 1. Distribution of Server's Packet Size

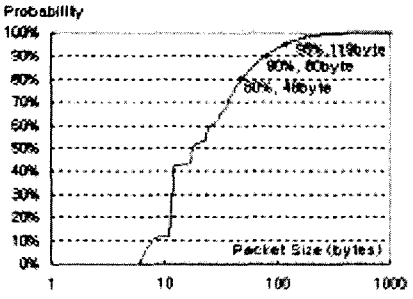

Figure 2. Cumulative Distribution of Server's Packet Size

Figure 1,2 shows the distribution of server packet size and cumulative distribution of server packet size. Hereafter, packet size represents the pure data bytes excluding the header bytes. As shown in the figures, packet sizes are very small and are narrowly distributed. Distribution of client packet size also shows the similar tendency.

3.3. Inter-Arrival Time (IAT)

IAT designates a gamer's behavior, especially his or her action interval during the game. Table 2 shows the statistics of server's Inter-Arrival Time.

Table 2. Statistics about IAT

	Server → Client	Client → Server
Total No.	1,640,323,336	1,860,209,597
Average IAT	298.3226msec	263.5825msec
Standard Dev.	68.65	52.92

Figure 3, 4 shows the distribution of inter-arrival time and cumulative distribution of IAT.

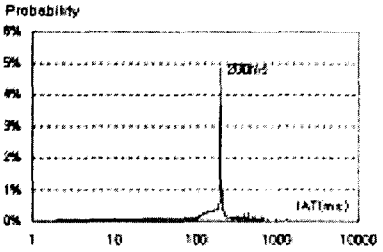

Figure 3. Distribution of Server's IAT

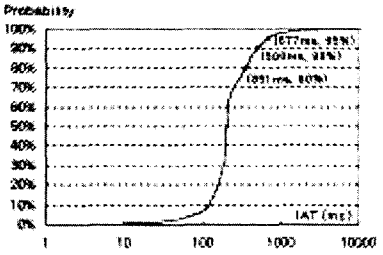

Figure 4. Cumulative Distribution of Server's IAT

Peak point of inter-arrival time stood at 200ms. 90% of inter-arrival time was shorter than 500ms from. It implies that a gamer sends at least a packet in a second. Average inter-arrival time was 298.32. It means that clients and server sends approximately 4 packets per second to each other. Distribution of client IAT also shows the similar tendency.

4. Traffic Generator

MMORPG traffic has very small packet size and bursty inter-arrival time. So we focus on packet size and interarrival time to analyze network game traffic.

The basis of algorithm has simple processes that are

sending a packet of a specified size, waiting for a specified interval, and repeating the process. The generator chooses random number according to uniform distribution to chooses an interarrival time and a size of the packet. Then the generator selects packet size and interarrival time from weighted bucket, which considers the weight of the appearance frequency according to random number.

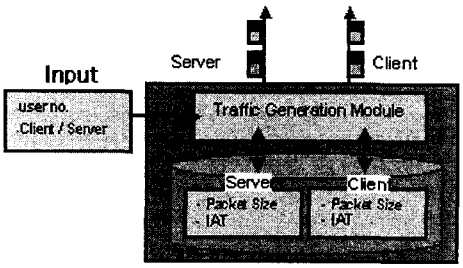

Figure 5. Architecture of Traffic Generator

The figure 5 shows the structure of a traffic generator. The generator produces a fitted traffic based on option values and internal traffic characteristic database. To implement the traffic generator we add new MMORPG application agent to NS.

5. Simulation

For simulation we create 100 client nodes and 1 server node. And then we make full duplex links between each clients and server with 1.5Mbps bandwidth and 10ms link delay. We make clients and server to maintain connections.

Table 3. Summary of Simulation Results

	Server	Client
Total Packet no.	12,133	13,823
Mean Packet size	36.1409 bytes	9.5460 bytes
Mean IAT	0.2884 sec	0.2554 sec

5.1. Statistical Testing using T-Test

We use 'T-Test' to verify that the trace generated by MMORPG traffic generator has identical characteristics with actual traffic. The t-test assesses whether the means of two groups are statistically different from each other [6]. This analysis is appropriate when you want to compare the means of two groups.

Table 4. T-Test Results of packet size

		Packet Size			
		Average	Variation	T	T0.05(N)
Server	Actual	36.74	3494.85	0.0890	1.9600
	Simulation	36.14	3698.33		
Client	Actual	9.44	23.98	1.7218	1.9600
	Simulation	9.55	25.36		

Table 5. T-Test Results of Inter-Arrival Time

		Inter-Arrival time			
		Average	Variation	T	T0.05(N)
Server	Actual	0.29	0.22	1.5567	1.9600
	Simulation	0.29	0.21		
Client	Actual	0.26	0.16	1.8861	1.9600
	Simulation	0.26	0.16		

In a above two cases, value of T is smaller than T(N) under the error limit 5%. Consequently, we can confirm the distribution of actual trace is identical with the distribution of simulation.

6. Conclusion

In this paper, we measured the traffic of MMORPG and analyzed its characteristics such as the distribution of packet size and the inter-arrival time. According to analysis in chapter 3 the traffic that is generated by MMORPG consisted of large bursts of short packets.

Based on this analysis, we could implement the traffic generator for MMORPG and had shown that the trace generated by generator had identical characteristics with actual traffic.

This research result is restricted in its generality because just one game was measured. For the improvements of its generality, some more measurements of other network games are needed. And by using a result of the analysis about network game traffic and the traffic generator which presents in the paper, we will continue research about new transport protocol and router that is suitable to a game traffic.

Bibliography

[1] McCreary S., clafy k., "Trends in wide area IP traffic patterns - A view from Ames Internet Exchange", ITC spec. Seminar, 2000.

[2] Wu-chang Feng et al, "Provisioning On-line Games: A Traffic Analysis of a Busy Counter-Striker Server", IMW2002, May 2002.

[3] Johannes Farber, "Network Game Traffic Modelling", NetGames2002, April 2002.

[4] Dave LaPointe, Josh Winslow, "Analyzing and Simulating Network Game Traffic", A Major Qualifying Project Report, Worcester Polytechnic Institute, December, 2001.

[5] http://www.lineage.co.kr

[6] Jay L. Devore, "Probability and Statistics for Engineering and the Sciences", Duxbury